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A FIRST ORDER APPROXIMATION OF SATIATION TIME: $(IRT)^2/R_t$

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Summary.—Habituation, satiation, adaptation, and boredom are a few of the words used to label the behavioral consequences of a fundamental operation: repeated and protracted presentation of a stimulus. The cumulative measure of the response associated with that stimulus is expected to display an inflection at some time T_t after which the slope approaches zero. T_t can be estimated by dividing the square of the interresponse time $(IRT)^2$ by the duration of the response associated with reinforcement (R_t), where R_t is expressed in the nearest whole temporal unit of interresponse time. Calculated T_ts for habituation to the same sexual, aggressive, or social stimuli are compatible with general observation.

When a novel stimulus is presented in a repeated and protracted manner to a normal organism, the cumulative measure of the response associated with that stimulus is expected to display an inflection point (time T_t) after which the slope approaches 0. Depending upon the specific situation and the discipline, an organism at time T_t would be described as approaching habituation, satiation, adaptation, saturation, and sometimes extinction. This essential behavioral operation can be seen in everyday expressions such as "getting used to," "tired of," or "bored with."

The general occurrence of this phenomenon appears to be remarkably persistent in both simple and complex behaviors. Initial acquisition- or satiation-like cumulative response curves are typified by initial slow rates of responding ("warm-up"), maintained maximum rates of responding and an inflection point (T_t) after which the response rate approaches a minimum value. The patterns are seen in cumulative response records for lever presses, consumer habits, sexual displays, and even battles in war.

An order of magnitude, quantitative prediction of the time required for an organism (or group of organisms) displaying a response (especially a consumptive response) to approach T_t should involve fundamental behavioral parameters. As most operant behaviorists have observed, either implicitly or clearly in the laboratory, two factors: IRT (interresponse time) and R_t (duration of the response associated with reinforcement) qualitatively determine T_t ("satiation" time).

Using a simple dimensional analysis procedure, the expression $(IRT)^2/R_t$, where R_t is expressed in the nearest whole unit of interresponse time, was selected as a first-order prediction of the time required for the cumulative record of R to display T_t (inflection towards zero). Temporal units of seconds, minutes or days (d) can be used. The relationship is based upon two assumptions: final dimensional units must be appropriate (real) values and in a *homeostatic temporal* system the relationship between the durations of the events and the inter-event intervals must be non-linear (elsewise the two become identities).

Several examples indicate that the relationship may have some general value. If, for example, a typical lever-press response has $R_t = 1$ sec. and the average time between reinforcements is 30 sec. during the initial acquisition, then the cumulative record should reach an inflection point after about 15 min. If the interresponse time is 1 min. and the R_t is still 1 sec. (0.017 min.), then T_t should be about 60 min.

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Instead of lever presses, suppose a more complex behavior such as a student's response to the same class (or subject) is used. If the class period (R_t) is 1 hr. (or 0.04 days) and the interresponse time averaged 3 days, then T_t would occur after about 225 days (7.5 mon.) or a school term. If the R_t is 2 hr. (0.08 days) and the interresponse time is about 1.5 days (summer school), then T_t should become evident within 28 days (about 4 weeks).

Two conceptual examples, satiation to a single sex partner and the same war stimuli, suggest the general nature of the prediction. Suppose a couple displays sexual behavior with a R_t = 30 min. (or 0.02 day) every day (interresponse time = 1 day). In this case, T_t should be evident after about 50 days. On the other hand, if the interresponse time was once a week (IRT = 7 days) then T_t would be about 7 yr. In the war situation, suppose, the average R_t of a battle is 1 day and the typical interresponse time is 30 days, then T_t should occur within 2.5 yr. If the interresponse time was every 3 mo. and the R_t was 5 days (0.17 mo.), then the T_t would be 4.5 yr.

As T_t approached, two classes of behavior would emerge: a general form associated with the satiation-induced decreased responding and a response rate-related behavior reflecting how quickly T_t was achieved. If the T_t is reached very quickly, e.g., within 30 days with interresponse times of one day, then behaviors similar to the frustrative aggression following extinction of continuous reinforcement would be expected. The specific responses would reflect the particular pattern of behavior. For the students', sex and war behaviors, these responses might be labeled boredom, lethargy, search for other stimuli (partners), and general loss of morale, respectively. Behaviors associated with high rates of responding or quick T_ts would include vandalism (to university stimuli), verbal hostility or temporary separation (from the sex partner), or fragmentation of a group and within-group aggression (towards relevant army cues).

$(IRT)^2/R_t$ would be most applicable for *novel* stimuli and *consumptive* responses. As time since initial exposure to the novel stimulus increased without T_t occurring, the more likely the complex reinforcement schedules would contribute to the continuation of the response display. No doubt, there must be some critical total duration for the response to be displayed before T_t is reached so that the complex learning factors can become effective, otherwise the response rates would decrease to intractable values.

The apparent similarity between cumulative response records of simple and complex behaviors, from lever presses to battles, could be a graphic illusion. The apparent universal nature of the habituation concept may be an artifact of language and conceptual analysis. However, if the operation is empirically persistent, then quantitative predictions must be possible in principle.

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